method, though not limited to, having arisen out of, and being exemplified by, Bessel's Functions.

I pass now to Lord Rayleigh's work subsequent to the award of the medal in 1887, which the Council are enjoined by the rules for their guidance to take into special consideration. In the *Philosophical Magazine* for August 1887 there is a paper "On the Maintenance of Vibrations by Forces of Double Frequency," a sequel to that "On Maintained Vibrations," *ibid.*, April 1883. To this subject Lord Rayleigh tells us his attention had been recalled by Mr. Glaisher's Address to the Royal Astronomical Society in the preceding February, in which he had given an interesting account of the treatment of mathematically similar questions, occurring in the Lunar Theory, to those herein considered, by Mr. Hill, published in the *Acta Mathematica* of the preceding year. The appearance of a "dissipative term" in the equation of motion of the vibrating body prevents it being treated as a special case of Hill's similar equation in the motion of the Lunar Perigee. The results are expressed by determinants, and one of the recent papers of Dr. Muir is referred to, on the relations of the special class of determinants involved to continued fractions. Applications to the case of the vibrations of a laminated medium, in which the mechanical properties are periodic functions of one of the co-ordinates—a problem connected with the colours of thin plates; and to the problem of the stationary vibrations of a string of variable density fixed at two points, follow.

In our Proceedings for November 1887, will be found a paper "On the Stability or Instability of certain Fluid Motions," forming a sequel to a former paper on the same subject in our eleventh volume (1880), to which Lord Rayleigh's attention had been re-directed by a recent work of Sir W. Thomson's. In this the subject is treated with greater generality.

In the following year Lord Rayleigh communicated to our June meeting a short but interesting investigation, "On Point, Line, and Plane Sources of Sound," giving rise to a definite integral the connection of which with Bessel's Functions is worked out by Lipschitz's method (*Crelle*, 1859), referred to in the paper of 1877 on Bessel's Functions.

In the Royal Society Proceedings, December 13, will be found a paper in which Mr. Love's objections (Phil. Trans., 1888, A., p. 545), to the line of argument followed in Lord Rayleigh's paper in the thirteenth volume of our Proceedings (1881), "On the Infinitesimal Bending of Surfaces of Revolution," are replied to with great fulness. The interest aroused by these discussions will be well remembered by those who followed them; and allusion to them has since been frequently made at our meetings.

The same memoir by Mr. Love drew forth another mathematical investigation by Lord Rayleigh (Roy. Soc. Proc., February 26, 1889), "On the Free Vibrations of an Infinitely Long Cylindrical Shell."

At our meeting, April 11, 1889, a paper by Lord Rayleigh was read, "On the Free Vibrations of an Infinite Plate of Homogeneous Isotropic Elastic Matter," a particular case of which "On Waves Propagated along the Plane Surface of an Elastic Solid" had been investigated in a communication to our November meeting of the year 1885.

In the before-mentioned years (1888–89), Lord Rayleigh contributed four important papers in the mathematics of Physical Optics to the *Philosophical Magazine*.

(1) "On the Reflexion of Light at a Twin Plane of a Crystal" (*Phil. Mag.*, September 1888). For the calculation of reflexion at the surface between twin crystals, the electric theory of Clerk Maxwell is found to be the only one satisfying the conditions essential to success—as capable of explaining at once Fresnel's laws of double refraction and those governing the intensity of reflexion when light passes from one isotropic medium to another. Starting with Maxwell's equations connecting the components of the electric displacement and current, magnetic force, electro-magnetic momentum and force, and taking the plane of transition as $x = 0$, Fresnel's tangent formula for isotropic reflexion is obtained; then his law of velocity for propagation in a crystal.

Reflexion at a twin plane is then limited to the cases of the plane of incidence, being (1) coincident with, (2) perpendicular to, the plane of symmetry. In the former case it is shown that the ratio of the amplitudes of the reflected and incident light is equal to the difference of two expressions proved to be equal, whether the vibrations are parallel or perpendicular to the plane of incidence, and no light is reflected whether the incident light be natural or plane-polarized, or elliptically polarized.

The values of the parameters which multiply the exponents in the two reflected waves in the second case are then worked out. Finally, particular cases of these general results are discussed.

(2) "On Interference of Light radiated from Moving Molecules" (*Phil. Mag.*, vol. xxvii. 1889) combats Ebert's conclusions by showing that the maximum admissible retardation is 4·5 times greater than assumed by him (*Wied. Annalen*), whence the width of the spectral lines should be much greater than found, which would involve a blow at the dynamical theory of gases.

(3) "On Complete Radiation at a Given Temperature" (*ib.*), founded on Gouy's "Theory of Irregular Impulses," investigates what type of similar impulses would by their aggregation represent complete radiation. The probability of various amplitudes depends on principles explained in an article in the *Philosophical Magazine*, August 1880, "On the Resultant of a Large Number of Vibrations of same Pitch and Arbitrary Phase." The form of impulse (familiar in the Theory of Errors)—

$$\phi(x) = \text{exponent } (-c^2x^2),$$

which is resolved into harmonic components by Fourier's Theorem, is discussed.

(4) "On Achromatic Interference Bands" (*Phil. Mag.*, vol. xxviii., August and September 1889). A development of notice of in the article "Wave Theory" ("Enc. Brit.," 1888), founded on Cauchy's law of dispersion; with a reference to Mascart, "Achromatism of Interference" (*Comptes Rendus*, March 1889).

These abstracts, imperfect as they are, may serve to convey to those who have not closely followed his work some idea of the great variety of subjects in Mixed Mathematics discussed and advanced by Lord Rayleigh, and on which that distinguished reputation in these domains is founded, their recognition of which the Council of the London Mathematical Society desire to mark by the present award of the De Morgan Medal.

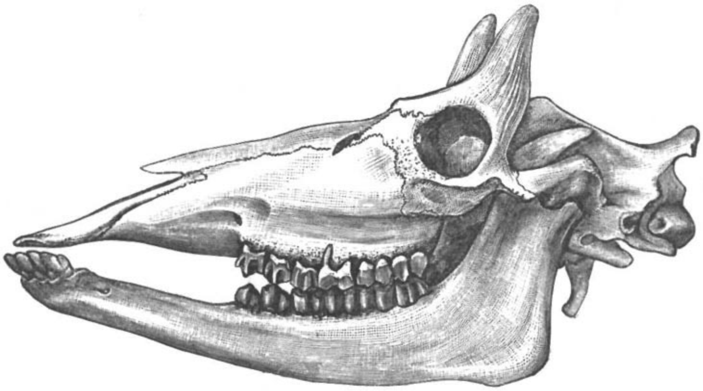
A NEW FOSSIL MAMMALIAN FAUNA.

THE trustees of the British Museum have recently added to the collection at South Kensington a large series of fossil remains of mammals purchased from Prof. C. J. Forsyth-Major, which are of especial interest from several distinct points of view. These remains were obtained within the last two or three years by Prof. Forsyth-Major from a Tertiary deposit in Samos—an island in the Turkish Archipelago, lying immediately opposite the town of Ephesus, and to the south-south-west of Smyrna. This deposit, which has been discovered only quite recently, appears to be absolutely full of the bones of mammals; and in this respect it agrees with the contemporary deposits of the celebrated Pikermi ravine near Athens, the wonderful mammalian fauna of which has been fully made known to us by the labours and writings of Prof. Albert Gaudry, of the Paris Museum, and other palæontologists.

The deposits at Samos have, however, one great advantage over those of Pikermi. Thus, in the latter locality the rock in which the bones are embedded is stained of a brownish-red colour, and very frequently adheres so closely to the bones that they cannot be properly cleaned from matrix; whereas in the case of Samos the rock is of a buffish-white, and can be completely removed from the specimens. This whitish colour of the Samos bones renders them peculiarly attractive objects in a museum; and the contrast between the white bones and the pale-brown of the enamel of the teeth in the magnificent series of skulls now displayed in the Museum is very striking. So well preserved, indeed, are these specimens that many of the skulls are almost as well suited for precise anatomical comparison as those of existing species.

The number of specimens from these deposits acquired by the Museum is no less than 533; the whole of these, with the exception of one bone of a bird, belonging to mammals. As another collection of at least equal extent has been acquired by the Museum at Geneva, the importance of this newly discovered fossil fauna may be readily estimated.

The discovery of this ossiferous deposit, taken in conjunction with that of the equivalent beds at Maragha, in Persia, which were brought to the notice of the scientific world only a few years ago, indicates that there is still hope of much further knowledge of the Tertiary mammalian fauna being eventually obtained by the full exploration of regions lying beyond the European area. As we have already mentioned, the Samos deposits are the equivalents in point of time with those of Pikermi in Attica, and of Maragha in Persia; this identification resting upon the general similarity of the fauna of the three areas, although each locality has some peculiar types not known in the others. The researches of Mr. W. T. Blanford and others have shown that we must assign a Pliocene age to the deposits at Pikermi. And with our present knowledge, the Pikermi fauna may now be traced from Baltavar in Hungary, through Greece, thence to Samos, Persia, Baluchistan, the Punjab, and so to the Siwalik Hills of Northern India, the mammalian fauna of which was the first to be brought to light through the classic labours of Falconer and Cautley. From this fauna, which forms a belt in the regions surrounding the whole of the north-eastern frontier of Africa, it is now pretty certain that the modern mammalian fauna of that continent was derived; and it is noteworthy that the fauna of Samos, and still more that of the Siwaliks, contains the greater number of forms most closely allied to those of Africa. In Pikermi and Samos no true elephants occur, but in the Siwaliks elephants more or less closely allied to the existing African and Indian species are abundantly represented.



Profile view of the skull of *Samotherium*, from the Pliocene of Samos. Much reduced. (From "Guide to British Museum.")

Among the mammals discovered at Samos, a large number are identical with those occurring at Pikermi. Thus, the well-known three-toed horse (*Hipparion*) is especially common in both localities. The rhinoceroses and mastodons likewise appear to have been, in most cases at least, specifically the same. Again, many of the antelopes found at Pikermi, some of which are allied to the African oryx and others to the koodoo, reappear at Samos. A large ruminant from Samos, as yet undescribed, but to which the provisional name *Criotherium* has been applied, appears, however, to be an antelope totally unlike any existing form. In this remarkable animal the horns are set on the extreme vertex of the skull, as in the hartebeest, the gnu, and the ox, but are extremely short, tightly twisted, and bent right in front of the forehead, in a manner totally unlike that found in any existing antelope.

Perhaps, however, the most remarkable of the new mammals discovered at Samos is the large ruminant for which the name *Samotherium* has been proposed. Of the skull of this creature we are enabled, by the courtesy of Dr. Woodward, to give a figure. It will be seen from this figure that the general proportions and contour of the skull are very similar to those of the giraffe; and the molar teeth are practically indistinguishable from those of the latter. The remarkable feature of this skull is, however, the presence of a pair of upright horn-cores, situated immediately over the eyes, and inseparably connected with the frontal bones, of which indeed, as in the antelopes, they form mere projections. This condition is very different from that obtaining in the giraffe, in which, it need hardly be said, the so-called horns are short bony processes, covered with skin in the living condition, and entirely distinct from the frontal bones. The horn-cores of the samothere are, indeed, very similar to those of certain Pikermi antelopes, and were, in all probability, sheathed in horn in the living animal. This ruminant appears, therefore, to indicate a close genetic connection between the giraffes and the antelopes; and since the giraffe itself is very closely allied to the deer, while the extinct Indian sivathere exhibits many points of affinity with the giraffe, but appears to have had deer-like antlers which were never shed, we see how little importance can really be attached to horns and antlers as indicative of want of affinity, or the reverse, between their respective owners. Indeed, there can now be but little doubt that deer, giraffes, prongbucks, and antelopes, are all descended from a common stock; the intermediate and annectant types having mostly died out, although the evidence of their former existence is now slowly but surely accumulating.

The only other mammals calling for especial notice are a species of aard-vark (*Orycteropus*) and a pangolin. The aard-varks, it need scarcely be said, are now entirely confined to Africa and Syria, and the occurrence of an extinct species at Samos may indicate that this group of animals originally reached Africa from the north-east. The fossil pangolin is very considerably larger than any of the existing species, and has been referred to an extinct genus. Since no fossil pangolin has been found in any European deposits, the occurrence of this extinct type is of some interest.

Lastly, we must not omit to mention that the deposits at Samos have also yielded remains of an extinct ostrich, although this species is unrepresented in the collection acquired by the British Museum. The African ostrich is known to have ranged into Persia and Baluchistan within the historic period, and since the genus also occurs fossil in the above-mentioned Siwalik deposits of Northern India, the evidence of its former existence in Samos shows that it once inhabited the whole of that extensive belt of country flanking the north-eastern frontier of Africa, which seems, as we have already mentioned, to have been the original home of the modern Ethiopian fauna.

In conclusion, we venture to express the hope that means will ere long be found by which this magnificent collection of fossil remains will be described and illustrated in a manner worthy of its importance and interest.

R. L.

NOTES.

WE learn that the Weather Service of the United States hitherto under the direction of the Chief Signal Officer, is to be transferred to the Agricultural Department after July 1, 1891. A chief will be appointed at a salary of 4500 dollars a year. The present Signal Corps will be discharged from the army, and will thereafter serve as civilians.

THE first *conversazione* for the season of the Royal Microscopical Society will be held in the Society's rooms, 20 Hanover Square, on the evening of Monday, December 1.

ON Friday last, a marble bust of William Symington was unveiled in the west wing of the Museum of Science and Art, Edinburgh, by Sir William Thomson, who said that Symington was the real discoverer and the practical originator of the steamboat. It was interesting to note that Symington exhibited before the Professors of Edinburgh University a model of a carriage to be moved on the public roads by the power of steam. In 1803, Symington constructed a steamer which took in tow two laden sloops, each 70 tons burden, on the Forth and Clyde Canal. The unveiling of the bust took place amidst loud cheering. Sir R. Murdoch Smith, on behalf of the Museum authorities, accepted the custody of the bust. Amongst those present at the ceremony was Mrs. Dickie, Glasgow, a granddaughter of Symington. The bust is by D. W. Stevenson, R.S.A.

M. TCHIHATCHEF, whose death we lately recorded, left 100,000 francs to the Paris Academy of Sciences, to provide prizes for naturalists who have made noteworthy Asiatic researches.

SOMEWHAT late we learn that Dr. Jose Jéronimo Friana died at Paris on October 31. The cause of his death is not stated, but the fact that a daughter died in the same house within three days of her father's death points to an epidemic. Dr. Friana was a native of New Granada, born in 1828, and previous to his coming to Europe he was attached to a Survey Commission, and made a collection of more than 5000 species of plants. About the year 1860 he came to Europe with his family, and never returned to his native country. The principal object of his visit to Europe was to determine his plants and prepare a Flora of New Granada. For this purpose he resided partly in Paris and partly at Kew, and spent some years working out his collections. In conjunction with the late Prof. J. E. Planchon, he commenced publishing a "Prodromus Floræ Novæ Granatensis"; but this fell through, partly, we believe, in consequence of a lack of funds, partly in consequence of Dr. Friana's time being occupied by consular and medical duties. For many years he resided wholly in Paris, and filled the position of Consul-General of the Republic of Colombia. Always hoping to be able to resume his favourite botanical pursuit, he kept his large collections at his residence. Among his published botanical work is a monograph of the Melastomaceæ, which appeared in the Transactions of the Linnean Society, and "Nouvelles Etudes sur les Quinquinas," containing *facsimiles* of Mutis's original drawings. The author visited Madrid, and studied the materials collected by Mutis. Apart from his scientific attainments, Dr. Friana was much loved for his extreme amiability.

HORTICULTURE has sustained a severe and almost irreparable loss in the sudden and unexpected death of Mr. Shirley Hibberd, which we recorded last week. An enthusiastic horticulturist, an accomplished writer, and a fluent and clever speaker, Shirley Hibberd occupied a position that it will be difficult to refill. He was sixty-five years of age, and for more than half that period he has been a constant figure at, and has taken a leading part in, the principal Shows and Congresses in connection with gardening and garden-botany. For upwards of thirty years he was editor of the *Gardener's Magazine*, and he was also the author of many little treatises of considerable literary merit. At the recent Chrysanthemum Show of the National Society of Chrysanthemum Growers, held at the Aquarium, Shirley Hibberd was the most prominent man, both in the lecture-room and as a speaker at the banquet which took place on the Thursday preceding his death. Indeed, it is supposed that he caught a chill in the conference-room, and, bronchitis supervening, the fatal result speedily followed.

IN the Reports on the progress and condition of the Royal Gardens, Kew, from 1862 onwards, there are many useful notes respecting economic and other plants. An index to these notes has just been issued, and will be welcomed by all who have preserved copies of the Reports. The work appears as Appendix III. of the *Kew Bulletin*. In this excellent periodical, to which we have often referred, are now published all notes that may be too detailed for the Annual Report on economic products and plants, to which the attention of the staff of the Royal Gardens has been drawn in the course of ordinary correspondence, or which have been made the subject of particular study at Kew. The preface to the new index concludes with the following statement:—"The *Bulletin*, of which three volumes are already published, and the fourth is in course of publication, may be looked upon as furnishing in a detailed and timely form the special information formerly included in the Annual Reports, but which a necessary economy of space precluded being treated at the length which is possible in the pages of the *Bulletin*. It may be added that the *Bulletin* is published monthly by Her Majesty's Stationery Office, and it may be obtained from Messrs. Eyre and Spottiswoode directly, or through any bookseller."

FROM January 1, 1891, the *Globus* will be edited by Dr. Richard Andree, of Heidelberg, by whose father the journal was established nearly 30 years ago.

THE Council of the University College of North Wales has just purchased for the College library the well-known collection of books belonging to Mr. E. Watkin, of Manchester (formerly of Pwllheli). It consists of upwards of 10,000 volumes, many of which are works relating to botany, chemistry, geology, and other departments of science.